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Development and Implementation of an Automated Course and Program Assessment Tool (ACAT)

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On the Development of an Automated Course Assessment Tool

Abstract

Higher education assessment is typically addressed at three levels: course, program, and institution. While commercial products for aid in the assessment process exist, a developmental Automated Course Assessment Tool (ACAT) is presented. Primary features and functionality include simple and efficient set-up of course outcomes and the associated weighted mapping of performance indicators, Moodle integration, "No Submit Analysis," basic statistical analysis, basic correlation studies, and auto-generation of a course outcomes assessment summary table. In this paper, extended functionality to program-level outcomes and enhancements to course-level outcomes is discussed.

Introduction

Assessment of the effectiveness of higher education is a continuous improvement process. Assessment is typically addressed at three interconnected levels: course, degree program, and institution. Indeed, various accreditation organizations[1, 2] insist on continuous assessment through established standards and guidelines. To aid in the assessment process, numerous commercial software and/or service products are available[3, 4, 5, 6]. However, any given product has both desired and undesired features and functionality. In addition, the complexity of some products might even be viewed as "overkill" if one seeks direct and simple tools to aid in assessment -- tools which will be used effectively and thoroughly by faculty, staff, and administration. Numerous institutions have developed tailored systems, typically computer based, to aid in the process. The works of Poger[7], Boff [8], Laverty[9], and Elnaffar[10] summarize typical examples of such efforts. This paper summarizes the on-going development of an Automated Course Assessment Tool (ACAT) and enhancements to aid in auto-assessment of program-level outcomes. As this software tool evolves, its future, more descriptive name is anticipated to be Academic Assessment Tool (AAT).

Background and motivation

Historically, course-level assessment at Daniel Webster College (DWC) is completed after a semester ends. This process involves generation of a table that summarizes the percentage of students who met, partially met, or failed to meet each course outcome. This summary is carried out for each Performance Indicator (PI) assigned to a given outcome (assignments, exams, etc.). In addition, final grade distribution is tabulated and general observations made. Finally, the course instructor formally documents the response to three questions: What worked or did not work? What changes were made during the semester? What should be done differently the next time the course is offered? A sample course outcomes analysis is provided in the Appendix A for a freshman first-semester engineering design course.

The primary intent of this process is to facilitate a continuous course improvement that is supported by basic data (the aforementioned table with met, partially met, failed to meet summary data). While the intent is noble, some shortcomings to this process include the following:

- Consumes considerable faculty time
- Compliance is weak (especially with adjunct faculty)
- Does not fully utilize all available data in the course assessment process
- Does not facilitate "real time" assessment
- Does not allow for efficient "temporal" studies on course improvement to be conducted
- Is not easily and efficiently "fed into" program-level assessment

An automated software tool to aid in course assessment has previously been described[11]. In this paper, the basic course-level functionality of the tool will be summarized, and extensions for both course-level and program-level assessment discussed.

ACAT course-level assessment overview

The Learning Management System (LMS) used by DWC is the open source Moodle[12] LMS. It allows external programs to access its database (e.g., grade book data). Before summarizing course-level assessment functionality of the ACAT software, its revised interface is discussed. Since its inception, the ACAT software has evolved to include program- level assessment features. As such, Figure 1 shows a screen shot of the revised main interface indicating the advanced capabilities (program-level assessment) and distinct Instructor/Dean functionality to maintain consistency in course outcome assignments and program-level mappings for assessment, as discussed in more detail below.

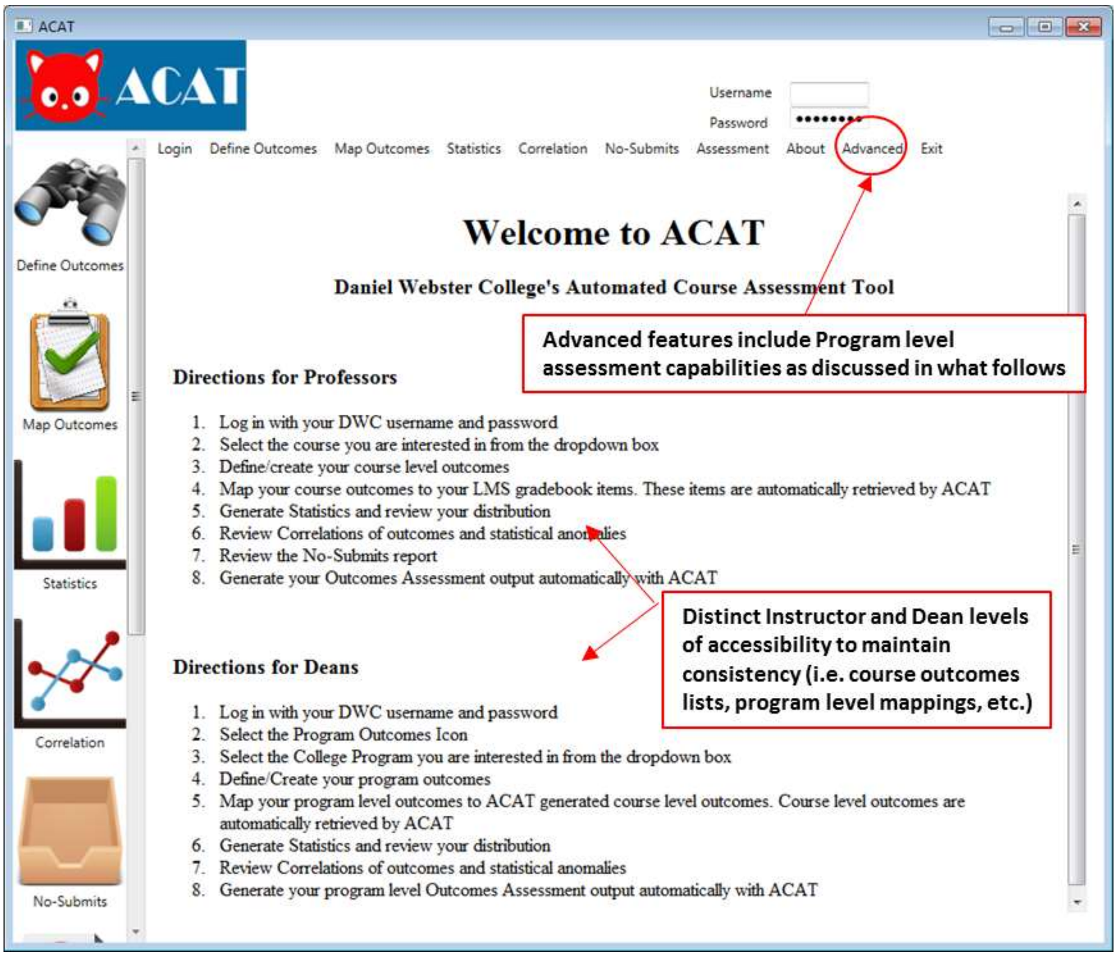

Figure 1. Screen shot showing the revised main interface with an "Advanced" option related to Program-level outcome assessment and distinct Instructor/Dean accessibility.

To maintain consistency and tractability, the assigning of outcomes to courses within the software has been modified as indicated in Figure 2. After the user logs in, the Define Outcomes menu option is selected. This will display a window with all the courses the professor is authorized to see. Upon selecting a course, the established Course Outcomes are displayed in a table. The professor may add, delete or modify Course Outcomes pending the Dean's and/or department approval. This approach facilitates consistency of course outcome assignments and tractability as course outcomes may change over time. Once Course Outcomes are selected, the software continues to allow the instructor to select a course outcome for editing and choose which PIs (as defined in the LMS grade book) will be mapped to the outcome. In addition, a weighting may be applied to any PI based on its relative importance to assessing a student's mastery of a course outcome. Functionality also includes a "no-submit" analysis as discussed in a previous paper[11].

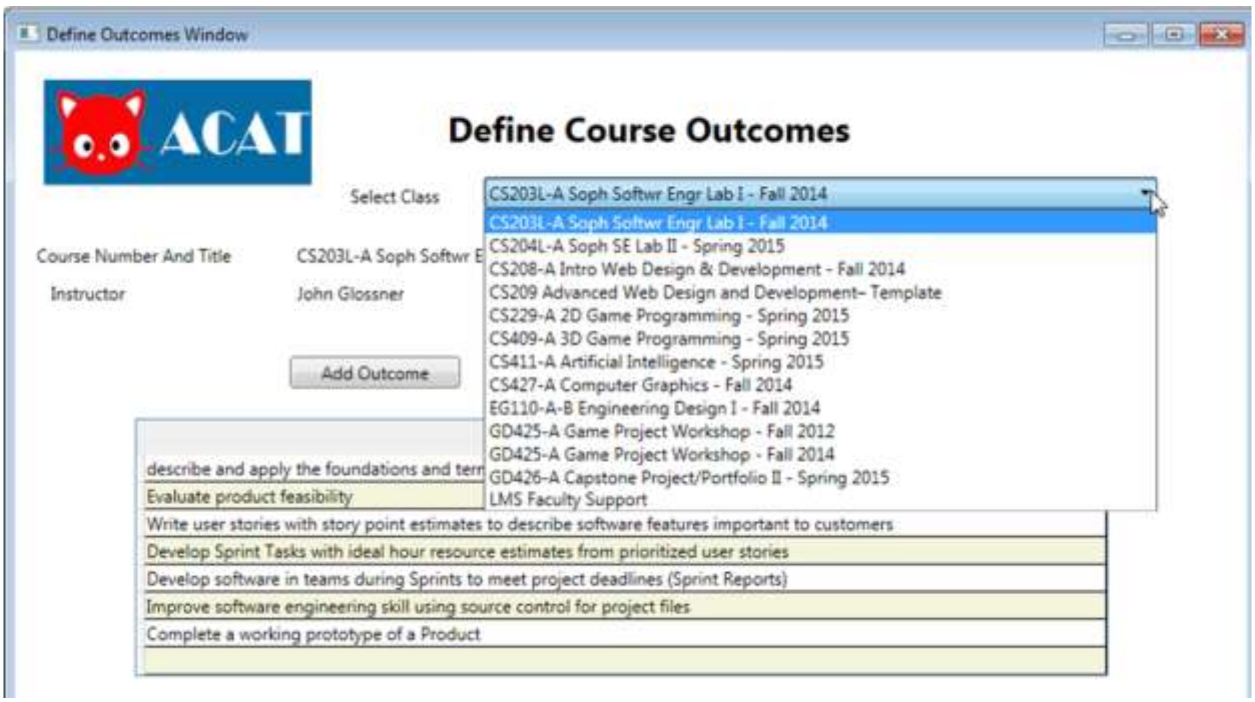

Figure 2. Screen shot showing the instructor's courses and the list of approved course outcomes for ease and consistency of assigning.

The ACAT software easily facilitates basic statistical analysis of data, even pooled data. For example, suppose one wishes to look at the basic statistics of the pooled data "all in-term Exam Grades." In addition, grades associated with a withdrawn student or grades of zero (no submission) are not to be included. Figure 3 shows the results of the basic statistical analysis including the histogram, sample count, mean, and standard deviation. Custom bin sizes and user-configurable options are also supported. Such analysis is useful in many ways, including checks for normality of distributions and trends in distributions over time.

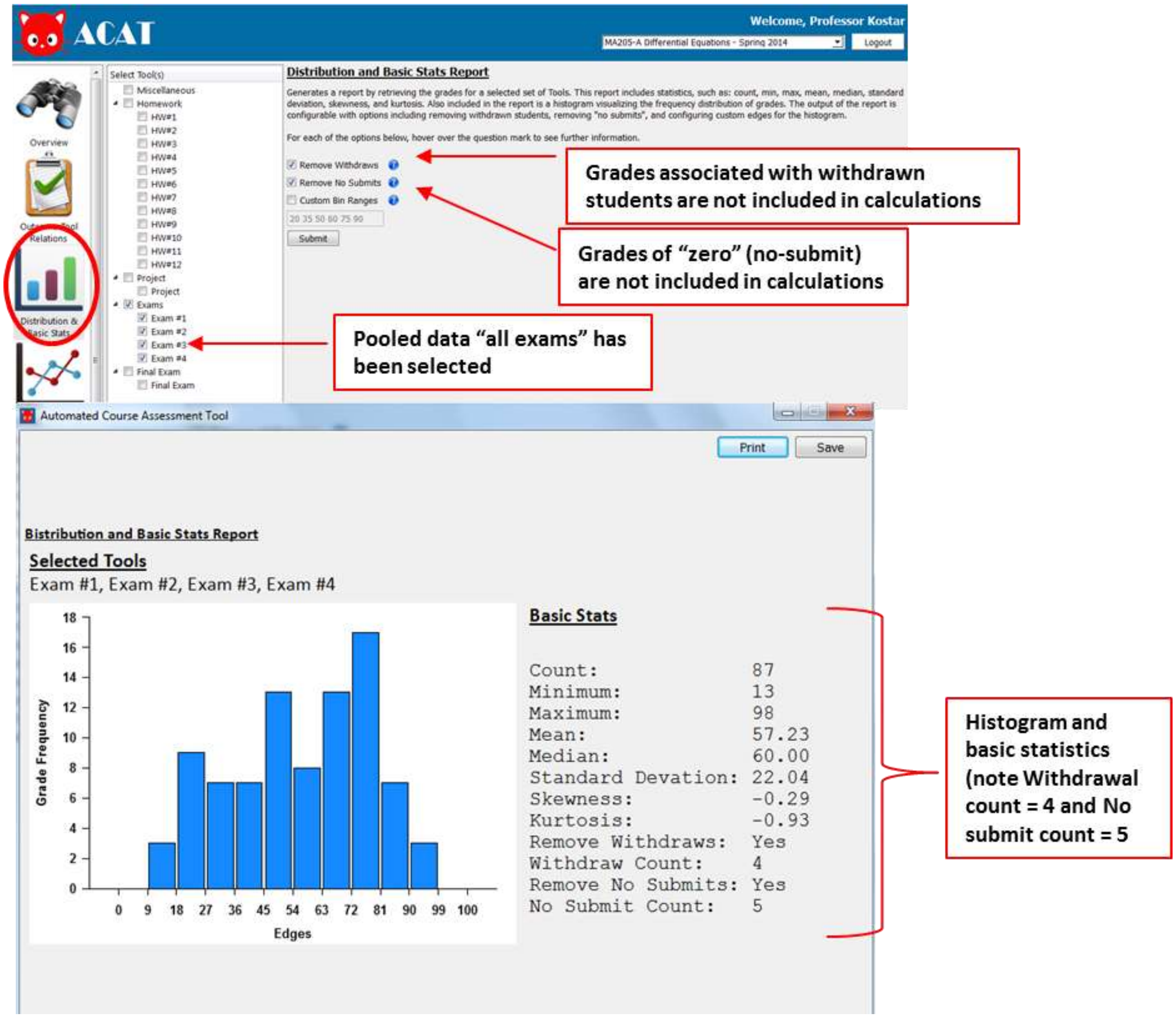

Figure 3. Screen shot showing the basic statistical analysis functionality of ACAT. In this example, we have selected the pooled data of Exam 1 through 4 and have chosen not to include student withdrawals or no submissions.

In addition, ACAT easily facilitates simple correlation studies. For example, suppose Homework Assignments 1 through 4 are practice for the understanding level evaluated in Exam #1. It is well known that, in an ideal world, a student who does well on homework should also do well on the related exam, and vice versa. As can be seen in Figure 4, a group of students has done well on the practice homework but performed poorly on the associated exam. Knowledge of this trend would likely motivate further investigation to determine the cause.

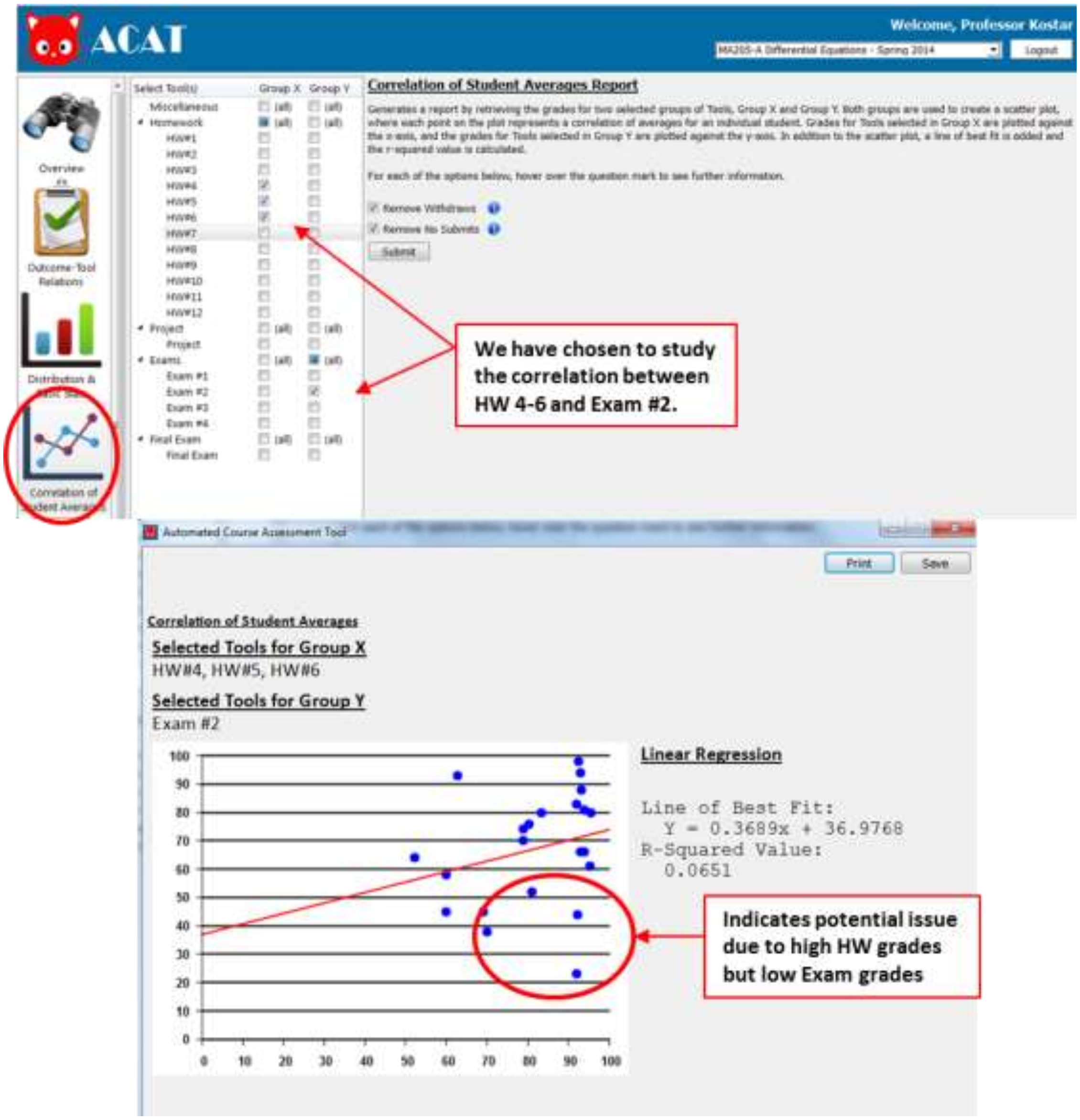

Figure 4. Screen shot showing a simple correlation study between homework grades and associated exam grades. Such studies are useful in identifying issues that might be investigated.

ACAT may be used to automatically generate the aforementioned summary table showing percent met, partially met, and failed to meet for each course outcome and the assigned Performance Indicators (Figure 5). As discussed above, Performance Indicators are assigned to course outcomes within the ACAT software, and a weighting may be applied to each. As example from above, for Outcome #1 in Figure 5, HW#1, HW#2, and HW#3 may be assigned a weighting of 15% each, while Exam #1 (a stronger indicator of outcome obtainment) may be assigned a weighting of 55%. Indeed, the resolution of a Performance Indicator may even be at the level of specific exam questions, etc. A "weighted average" summary for each course outcome may be automatically generated. As discussed in the next section, this weighted average data may be utilized to aid in program-level assessment. Finally, this table may then be manually augmented with the instructor's comments on potential future plans to improve obtainment of any given course outcome. In summary, ACAT's course-level functionality effectively generates an electronic database that may be readily accessed and utilized for tracking course improvement over time.

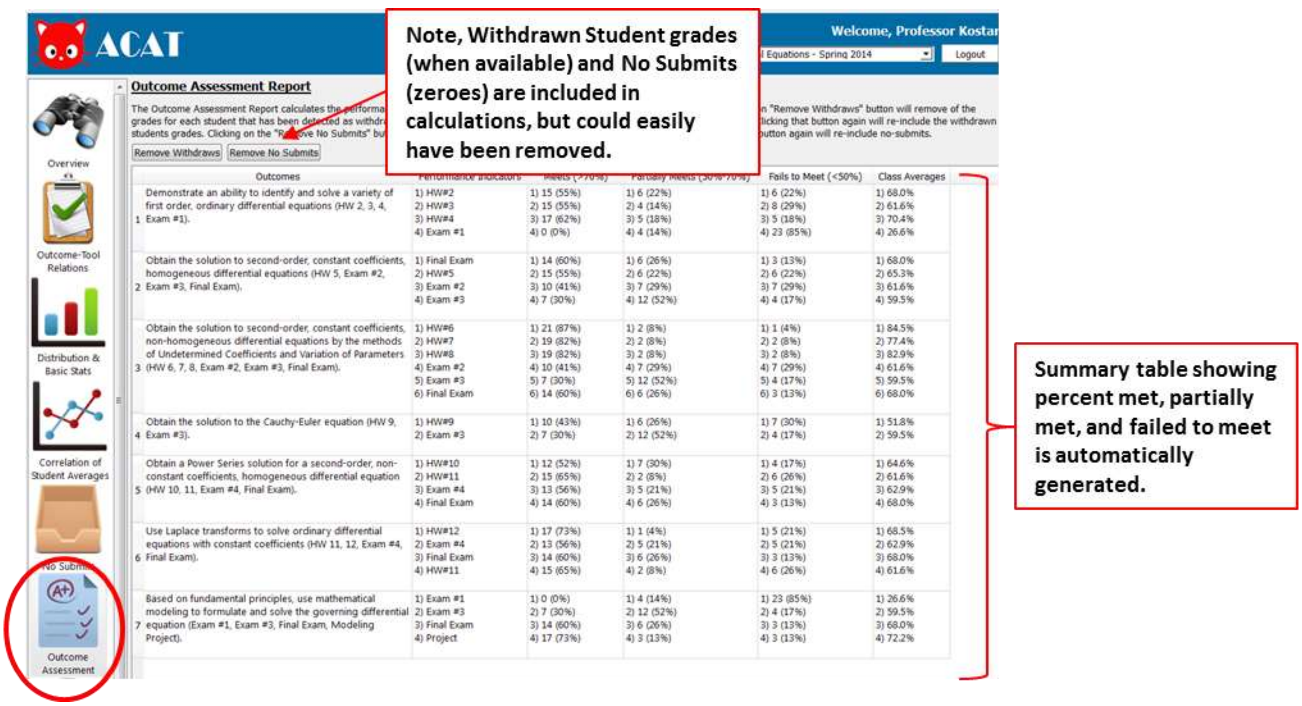

Figure 5. Screen shot showing an auto-generated summary table indicating the percent met, partially met, and failed to meet for each course outcome and each mapped Performance Indicator.

ACAT program-level assessment overview

This section will describe how ACAT can be used to link the assessment of course-level outcomes to program-level outcomes using the DWC mechanical engineering program as an example. Each required course in the program has an objective (essentially the purpose and goal of the course in the curriculum) and student learning outcomes (the set of measurable tasks to be mastered). Tables 1A and 1B show the relationship of the lower-division and upper-division courses to the program outcomes and signify the level of course contributions as Introductory, Reinforcement, or Emphasis.

		Freshman									Sophomore										
		Fall					Spring				Fall					Spring					
		CH 101	EG 110	EN 101	MA 201	PY 101	EN 102	EG 112	PH 215	MA 202	PH 216	EG 200	EG 207	MA 203	EG 208	EG 203	EG 202	EG 209	MA 205	EG 201	HU or SS 200
	Students in the Mechanical Engineering program at Daniel Webster College, at graduation, will have demonstrated:	Chemistry	Design I	College Writing	Calc I	Principles of Psychology	College Writing & Research	Design II	Physics I & Lab	Calc II	Physics II & Lab	Statics	Ins. & Meas.	Calc III	Mat. Sci	Dynamics	Strength	Thermo I	Diff. Eq.	Fluids	Elective
a	an ability to apply knowledge of mathematics, science, and engineering	I	I		I			I	I	I	I	I	I	R	I	R	R	R	R	R	
b	an ability to design and conduct experiments, as well as to analyze and interpret data	I	I					I	I		I		R		I		I			I	
c	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability		I					I					R								
d	an ability to function on a multi-disciplinary teams		I			I		I					R								R
e	an ability to identify, formulate, solve engineering problems		I		I			I	I	I	I	I	I	I	I	I	I	I	I	I	
f	an understanding of professional and ethical responsibility		I			I		I					I								R
g	an ability to communicate effectively	I	I	I	I	I	I	I	I	I	I	R	R	R	R	R	R	R	R	R	R
h	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	I	I					I	I		I		I								I
i	a recognition of the need for, and the ability to engage in life-long learning	I			I	I			I	I	I		I	I	I	I	I	I	R	I	R
j	a knowledge of contemporary issues	I		I		I	I											I			R
k	an ability to use the techniques, skills, and modern engr tools needed for engineering practice		I					I	I		I	I	R		I	I	R	I		I	
l	an ability to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes.		I					I	I		I	I	I		I	I	I	I	I	I	
m	an ability to work professionally in both thermal and mechanical systems areas.		I					I				I	I		I	I	I	I	I	I	

I = Introductory
R = Reinforcement
E = Emphasis

Table 1A. Course contributions to outcomes, lower-division courses

		Junior										Senior										
		Fall					Spring					Fall						Spring				
		EG 325	MA 315	EG 316	EG 318	HU or SS 200	EG 341	EG 333	EG 350	EG 310	HU or SS 300	EG 410	ID 401	EG 460	EG3xx/4xx	EG3xx/4xx	HU or SS 300	EG 420	EG 4xx	EG 461	EG3xx/4xx	HU or SS
	Students in the Mechanical Engineering program at Daniel Webster College, at graduation, will have demonstrated:	Int. Strength	Lin. Alg. & Num Meth	EE	Thermo II	Elective	Des. of Mach. Comp.	Controls	Vibrations	Design III	Elective	Heat Transfer	Senior Seminar	Capstone Design I	Technical Elective	Technical Elective	Elective	Thermal Design	Anal. & Exper.	Capstone Design II	Technical Elective	Elective
a	an ability to apply knowledge of mathematics, science, and engineering	R	E	R	R		E	E	E	R		R		E				E	E	E		
b	an ability to design and conduct experiments, as well as to analyze and interpret data		I	I				R		R		R		E				E	E	E		
c	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	R					R	R	R	R				E				E		E		
d	an ability to function on a multi-disciplinary teams					R		R		R	R			E			R			E		
e	an ability to identify, formulate, solve engineering problems	R	R	R	R		E	E	E	R		R		E				E	E	E		
f	an understanding of professional and ethical responsibility					R				R	E		R	R			E			R		
g	an ability to communicate effectively	R	R	R	R	R	R	R	R	R	E	R	E	E			E	E	E	E		
h	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context			I		I				R	R		R	R			R			R		
i	a recognition of the need for, and the ability to engage in life-long learning	R	R	R	R	R	R	R	R	R	E	R	E	E			E	E	E	E		
j	a knowledge of contemporary issues					R					E		E	E			E			E		
k	an ability to use the techniques, skills, and modern engr tools needed for engineering practice	R	R	R	R		R	R	R	R		R		E				E	E	E		
l	an ability to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes.	R	R	R	R		R	R	R	R		R		E				E	E	E		
m	an ability to work professionally in both thermal and mechanical systems areas.	R	R		R		R	R	R	R		R		E				E		E		

I = Introductory
R = Reinforcement
E = Emphasis

Table 1B. Course contributions to outcomes, upper-division courses

Each program outcome is measured with a set of performance indicators. As an example, in our Mechanical Engineering program, program-level outcome (L) is stated as:
an ability to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes.

This outcome is assessed with the following Performance Indicators:

1. MELPI1: Demonstrate an ability to model and analyze a mechanical or thermal system and its components
2. MELPI2: Demonstrate an ability to select standard components such as fasteners, gears, bearings, motors, and fans based on design needs
3. MELPI3: Demonstrate an understanding of manufacturing processes such as machining, welding, and casting
4. MELPI4: Demonstrate an ability to show proof-of-concept

Note that the notation indicates ME (mechanical engineering), L (program outcome L), and PI1 (Performance Indicator #1).

Using ACAT, each Performance Indicator can be linked to relevant course outcomes which have already been assessed by ACAT at the course level. As can be seen in Table 2, specific course outcomes for relevant courses are used to determine an overall average for each Performance Indicator. Year-by-year comparisons can also be generated.

an ability to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes

Introductory	Reinforcement	Emphasis
EG 110, 112, 200, 201, 202, 203, 207, 208, 209	EG 310, 316, 318, 325, 333, 341, 350, 410	EG 420, 460, 461
PH 215, 216 MA 205		

Specific courses used for assessment: EG 112, 310, 341, 420

	Assessed Value 2015			Assessed Value 2016		
MELPI1). Demonstrate an ability to model and analyze a mechanical or thermal system and its components	Met	Partially Met	Failed to Meet	Met	Partially Met	Failed to Meet
EG 310 - Conduct lab work and/or project work and apply the basic concepts commonly used in statistics to find the statistical measurements of the data and display the data in efficient graphic ways; and use current statistics software to analyze data and interpret results (Statistics Assignments and Quizzes) (Weight=1)	84.6	7.7	7.7			
EG 310 - Apply finite element analysis to solid models. Apply various failure theories to determine factors of safety, evaluate and animate deformations, and determine the best areas to remove material for weight reduction in the parts they design (Stress Analysis Assignments and Design Project) (Weight =1)	88.5	11.5	0.0			
EG 420 - Select and analyze a heat exchanger (HW 10, Exam #3, Final Exam) (Weight=1)	100.0	0.0	0.0			
Average	**91.0**	**6.4**	**2.6**			
MELPI2). Demonstrate an ability to select standard components such as fasteners, gears, bearings, motors, and fans based on design needs						
EG 341 - Analyze, design, and/or select a variety of machine components such as gear, bearing, and springs (HW, Exam #2, Exam #3, Final Exam, Project) (Weight=1)	80.0	20.0	0.0			
EG 341 - 4) Analyze and size power transmission shafts (HW, Exam #1, Final Exam, Project) (Weight=1)	83.4	13.3	3.3			
Average	**81.7**	**16.7**	**1.7**			
MELPI3). Demonstrate an understanding of manufacturing processes such as machining, welding, and casting						
EG 112 - Students will increase their ability to use a variety of machine-shop equipment such as lathes, milling, and CNC machines (Machine Shop assignments, Design Project)	**94.3**	**0.0**	**5.7**			
MELPI4). Demonstrate an ability to show proof-of-concept						
EG 341 - Incorporate several necessary machine components into the design of a mechanical device (Project) (Weight=1)	100.0	0.0	0.0			
EG 310 - Design and conduct experiments as part of the open-ended design project, and analyze, interpret and present / report on the data (Design Project) (Weight =1)	100.0	0.0	0.0			
Average	**100.0**	**0.0**	**0.0**			

Table 2. Program outcome (L) Performance Indicator results

For another example, the program-level outcome (G) is stated as: *an ability to communicate effectively*. This program outcome is assessed with the following Performance Indicators:

1. MEGPI1: Prepare effective written technical reports
2. MEGPI2: Prepare and deliver effective oral technical presentations
3. MEGPI3: Present information visually using professional-quality drawings, sketches, and graphs
4. MEGPI4: Adapt technical information to a non-technical audience

The specific course outcomes used to determine an overall average for each performance indicator are shown in Table 3.

an ability to communicate effectively		

Introductory	Reinforcement	Emphasis
EG 110, 112	EG 200, 201, 202, 203, 207, 208, 209, 310, 316, 318, 325, 333, 341, 350, 410	EG 420, 460, 461, ID 401
MA 201, 202	MA 203,205, 315	
PH 215, 216	HU or SS 200	HU or SS 300
CH 101, EN 101,102, PY 101		

EG 110, 310, 461

	Assessed Value 2015			Assessed Value 2016		
MEGPI1). Prepare effective written technical reports	Met	Partially Met	Failed to Meet	Met	Partially Met	Failed to Meet
EG 461 - Write effective technical communications for various purposes such as project proposals, progress reports, and project reports that are concise, use accurate grammar, correct spelling, and logical organization (technical reports)	**100.0**	**0.0**	**0.0**			
MEGPI2). Prepare and deliver effective oral technical presentations						
EG 110 - The students will be able to deliver a presentation that is well organized, complete, and conveys information clearly and concisely. (Topic Presentations, Milestones and Final Project Presentations) (Weight=1)	94.7	0.0	5.3			
EG 310 - Demonstrate communication skills via written and oral reports, and by generating engineering documentation from solid models (Design Project Milestones and Final Project Presentations and Reports) (Weight=2)	96.2	0.0	3.8			
Average	**95.7**	**0.0**	**4.3**			
MEGPI3). Present information visually using professional quality drawings, sketches, and graphs						
EG110 - The students will develop the sketching techniques required to visualize and characterize three-dimensional objects on a two-dimensional medium. (Sketching Assignments) (Weight=1)	63.0	20.0	17.0			
EG 110 - The students will develop engineering graphics skills and integrate the design process with graphics and solid modeling as the method for developing and communicating the solution of engineering problems. (Drawing Assignments, Drawing Quizzes, and Design Project) (Weight=2)	83.0	6.3	10.7			
Average	**76.3**	**10.9**	**12.8**			
MEGPI4). Adapt technical information to a non-technical audience						
EG 461 - Effectively communicate verbally; tailor oral presentations to different audiences, including non-technical and engineering professionals (presentations)	**100.0**	**0.0**	**0.0**			

Table 3. Program outcome (G) Performance Indicator results

Normally 300- and 400-level courses are selected for assessment of Performance Indicators, but for this outcome the freshman design course, EG 110, is also used. The complete course outcomes assessment matrix for EG 110 is shown in Appendix A.

In the evaluation of MEGPI2, the course outcomes used from EG 110 and EG 310 are shown in Table 4. Note that the weighting for EG 310 is twice that for EG 110 because it is a junior spring semester course, whereas EG 110 is a freshman fall semester course.

MEGPI2). Prepare and deliver effective oral technical presentations
EG 110 - The students will be able to deliver a presentation that is well organized, complete, and conveys information clearly and concisely. (Topic Presentations, Milestones and Final Project Presentations) (Weight=1)
EG 310 - Demonstrate communication skills via written and oral reports, and by generating engineering documentation from solid models (Design Project Milestones and Final Project Presentations and Reports) (Weight=2)

Table 4. Course outcomes used to evaluate program Performance Indicator MEGPI2

In the evaluation of MEGPI3, the course outcomes used are both from EG 110 and are shown in Table 5. In this case, the weighting of the second outcome is twice that of the first because it draws from a greater volume of student work.

MEGPI3). Present information visually using professional quality drawings, sketches, and graphs
EG110 - The students will develop the sketching techniques required to visualize and characterize three-dimensional objects on a two-dimensional medium. (Sketching Assignments) (Weight=1)
EG 110 - The students will develop engineering graphics skills and integrate the design process with graphics and solid modeling as the method for developing and communicating the solution of engineering problems. (Drawing Assignments, Drawing Quizzes, and Design Project) (Weight=2)

Table 5. Course outcomes used to evaluate program Performance Indicator MEGPI3

The use of ACAT for mapping specific course outcomes to program Performance Indicators provides a direct automated assessment of program outcomes. To properly assess program outcomes, additional direct and indirect indicators are normally used. Direct indicators may include standardized exams, oral exams, and portfolios, while indirect indicators might include student, alumni, and employer surveys, focus groups, and archival records. While ACAT does not address these other indicators, it does greatly simplify the assessment of program outcomes to the extent that it will make possible the generation of useful data on a real-time basis.

Conclusions and discussion

While commercial software and/or service packages are available to aid in assessment at all levels, they sometimes prove costly, complex, and generic. An in-development Automated Course Assessment Tool, tailored to the needs of DWC, has been presented. ACAT's features and functionality include:

- Efficient and consistent set-up of course outcomes and the associated weighted mapping of Performance Indicators.
- "No Submit" analysis.
- Basic statistical analysis.
- Basic correlation studies.
- Auto-generation of the summary table of course outcomes met, partially met, and not met, including a weighted average summary.
- Program-level assessment using course outcomes with software support in ACAT to map performance indicators to the program-level assessment.

Future work includes:

- Real-time (while the semester is in progress) basic statistical analysis for each course outcome (histogram, mean, standard deviation, etc.) that displays how well any given outcome is being met per its mapped and weighted Performance Indicators.
- Year-to-year historical comparison of student course outcome achievement to help determine the impact of instructional revisions and enhancements.
- A summary table of student versus course outcome, where the instructor may easily apply a rubric-like assessment with respect to how well individual students are obtaining each outcome.

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Appendix A

Outcomes matrix for EG110 Engineering Design I (27 students)

Outcomes	Performance Indicators	Results			Analysis Notes	Future Plans
		Meets (>70%):	Partially Meets (50%-70%):	Fails to Meet (<50%):	Class Averages:	
The students will begin to develop the ability to use the engineering design process as a method for solving complex, open-ended problems (Design Project)	Overall project score	26 (96.3%)	1 (3.7%)	1) 0 (0%)	Average: 85% Note that 8 students out of the 35 who started the course either withdrew or stopped attending and so were not included in these averages.	The presentation on the design process was revised this semester. Additional material will be added next semester in order to better prepare the students for the design process in Design III and the capstone sequence. Note that the overall average for the project was significantly better this year than last year.
The students will develop engineering graphics skills and integrate the design process with graphics and solid modeling as the method for developing and communicating the solution of engineering problems. (Drawing Assignments, Drawing Quizzes, and Design Project)	1) Drawing Assignments 2) Design Projects (Drawing component)	1) 18 (66.7%) 2) 27 (100%)	1) 8 (29.6%) 2) 0 (0%)	1) 1 (3.7%) 2) 0 (0%)	1) 80.6% 2) 91%	The modeling and graphics for the design projects was well done. For the most part students with low averages in the drawing assignments failed to turn in all the drawings, which obviously hurts their average. The use of the online working drawing review module seems to be effective in improving the project graphics and will be continued.
The students will develop the sketching techniques required to visualize and characterize three dimensional objects on a two dimensional medium. (Sketching Assignments)	Sketching Assignments	20 (74.1%)	3 (11.1%)	4 (14.8%)	Average: 74.3%	Add some online sketching instruction videos.
The students will be able to design, using appropriate software, a visually effective presentation. (Topic Presentations, Milestones and Final Project Presentations)	1) Topic Presentations 2) Final Project Presentations (communications component)	1) 20 (74.1%) 2) 27 (100%)	1) 7 (25.9%) 2) 0 (0%)	1) 0 (0%) 2) 0 (0%)	1) Average: 77% 2) Average: 93.5%	This semester, increased time and emphasis on presentation dry runs contributed to the improved quality of the design presentations. This emphasis will be continued. The topics presentations were done earlier in the semester, so as expected, the presentations were not as

Outcomes matrix for EG110 Engineering Design I - continued

Outcomes	Performance Indicators	Results			Analysis Notes	Future Plans
		Meets (>70%):	Partially Meets (50%-70%):	Fails to Meet (<50%):	Class Averages:	
						good as the final design presentations. These topics presentations were also preceded by dry runs.
The students will be able to deliver a presentation that is well organized, complete, and conveys information clearly and concisely. (Topic Presentations, Milestones and Final Project Presentations)	1) Topic Presentations 2) Final Project Presentations (communications component) 3) Final project presentations (technical component)	1) 20 (74.1%) 2) 27 (100%) 3) 27 (100%)	1) 7 (25.9%) 2) 0 (0%) 3) 0 (0%)	1) 0 (0%) 2) 0 (0%) 3) 0 (0%)	1) Average: 77% 2) Average: 93.5% 3) Average: 84.7%	See previous outcome. Continue increase emphasis on dry runs. Student performance on the results and conclusions sections was poor. Additional instruction in these sections will be added.
The students will be able to write a report in clear, precise language, using the standard parts of an engineering report. (Design Project Report)	Design Project Report (communications component)	27 (100%)	0 (0%)	0 (0%)	Average: 86.9 %	Additional up-front instruction on report content and format was given. Overall average is improved from last semester. Continue to expand online resources next semester.
The students will be able to apply fundamental engineering concepts involving free-body diagrams, tensile and shear stress, center of mass, torque and power curves for DC motors, power requirements, and multi-stage gear box design. (Engineering Fundamentals Quizzes and Design Project)	1) Engineering Fundamentals Quizzes 2) Design Project (technical component)	1) 24 (88.9%) 2) 27 (100%)	1) 3 (11.1%) 2) 0 (0%)	2) 0 (0%) 3) 0 (0%)	Average: 82.6 Average; 83.3%	Engineering fundamentals quizzes average was significantly improved. No explanation for this.

Outcomes matrix for EG110 Engineering Design I – continued

Outcomes	Performance Indicators	Results			Analysis Notes	Future Plans
		Meets (>70%):	Partially Meets (50%-70%):	Fails to Meet (<50%):	Class Averages:	
The students will function as responsible, contributing member of a design team. (Analysis of relative contributions of team members)	1) Analysis of relative percent contributions of team members – See table below	1) (Standard deviation<5) 8/11 (72.7%)	1) (Standard Deviation 5-10) 2/11 (18.2%)	1) (Standard Deviation >10) 1/11 (9.1%)	Average Standard Deviation: 3.26 Note that 7 students out of the 35 who started the course either withdrew or stopped attending and so were not included in these averages.	The results were improved this semester with seven teams reporting uniform contribution of their members. We utilized the team creation and peer evaluation tool called CATME from Purdue for the first time. This tool was used for the selecting the members of the teams. However, it was only used once for midsemester team evaluation. Increasing the frequency should improve the effectiveness of this tool. In our last evaluation of the course we recommended more up-front emphasis on team building and project management skills. Due to the workload of the teaching team we were not able to pull this off this semester but will try again next time.
The students will develop proficiency in the use of a variety of software tools such as Mathcad and Excel that are useful for engineering communication and analysis. (Computer Skills Assignments)	Computer Skills Assignments	26 (96.3%)	1 (3.7%)	0 (0%)	Average: 97.2%	Working well, no change planned.
The students will acquire a knowledge of the fundamental principles of the ABET Code of Ethics of Engineers. (ABET quiz)	ABET quiz	27(100%)	0 (0%)	0 (0%)	Average: 100%	Working well, no change planned.

Outcomes analysis for EG110 Engineering Design I – continued

Individual Team Member Percent Contribution

	Team 1	**Team 2**	**Team 3**	**Team 4**	**Team 5**	**Team 6**
Member A	33	45	50	40	50	33
Member B	33	45	50	20	50	33
Member C	33	10		40		33
Standard deviation	0	16.5	0	9.4	0	0

	Team 8	**Team 9**	**Team 10**	**Team 11**	**Team 12**	
Member A	50	57	33	53	50	
Member B	50	43	33	47	50	
Member C			33			Standard Deviation Ave.
Standard deviation	0	7	0	3	0	3.26

Observations about the class
Started the course – 35
Finished the course – 27
Grade breakdown:

A	A-	B+	B	B-	C+	C	D	F	W
11	3	2	0	0	4	5	1	6	3

What worked well? This semester, increased time and emphasis on presentation dry runs contributed to the improved quality of presentations. Thirteen new Jing videos for SolidWorks instruction, tips, and review were created and feedback from the students indicated they were helpful. Additional online resources were developed for report writing.

What changes did you make during the Academic Semester? This semester we utilized the team creation and peer evaluation tool called CATME from Purdue for the first time. This tool was used for the selecting the members of the teams. However, it was only used once for mid-semester team evaluation. Increasing the frequency should improve the effectiveness of this tool. As can be seen from the Individual Team Member Percent Contribution results, seven teams reported uniform contributions from their members, which is a great improvement. It seems unlikely that this improvement could be attributed to the use of CATME alone.

What would you do differently next time?

- In our last evaluation of the course we recommended more up-front emphasis on team building and project management skills. Due to the workload of the teaching team we were not able to pull this off this semester but will try again next time.
- Next year we plan to use peer evaluation earlier and more often.
- The presentation on the design process was revised this semester. Additional material will be added next semester in order to better prepare the students for the design process in Design III and the capstone sequence.